MONTHLY NOTICES

OF THE

ROYAL ASTRONOMICAL SOCIETY.

VOL. XXXI. *May* 12, 1871. No. 7.

WILLIAM LASSELL, Esq., F.R.S., President, in the Chair.

Henry Mann, Esq., Cleckheaton, near Normanton;
Clarence Edward Trotter, Esq., 33 Kensington Square;
Reginald Bushell, Esq., Hinderton Weston, Cheshire;
J. H. Blumm, Esq., H. M. S. Caledonia, Malta,

were balloted for, and duly elected Fellows of the Society.

On the Change in Colour of the Equatorial Belt of Jupiter.
By John Browning, Esq.

The last number of the *Astronomical Register* contains a report of a discussion on this subject, at the monthly meeting of the Royal Astronomical Society. With the exception of Messrs. Ranyard and Penrose, the whole of the speakers considered that no change had taken place in the colour of the planet.

It was suggested that the reason the colour on the equatorial belt is now seen by many observers, while it was not seen in previous years, is to be accounted for by the fact that within the last few years many observers have become possessed of silvered glass reflectors of large aperture.

With all deference to such admirable observers as the speakers, I would beg to point out that such an explanation will not hold good in my own case.

Five years ago I began making careful coloured drawings of *Jupiter* with a reflector of $10\frac{1}{2}$ inches aperture.

As long since as December 13, 1867, I drew attention to the fact that colour is best seen with small apertures or high powers.

I worked with powers from 350 to 500 whenever the air would permit. Although at that time I saw easily the coppery grey of the dark belts, and the bluish grey of the poles, I could detect no strong colour on the equatorial belt. Yet for the last two years the tawny colour of the equatorial belt has been more conspicuous than either.

It is true that during the last three years I have had a 12¼-inch equatorial reflector, but, owing to unfavourable atmospheric conditions, practically I have seldom indeed used more than 10 inches of aperture.

Several observers have seen the tawny colour of the belt with both refractors and reflectors of only three or four inches aperture.

The exact colour of the equatorial belt may be obtained by allowing a very powerful light to pass through a jet of steam, so that an increase in the luminosity of the body of the planet would completely account for the colour of the belt.

If, as I suspect, the colour appears periodically, we shall have probably to wait several years before we can decide this matter.

Colour observations are, of course, liable to many sources of error, but though observers may at different times receive different impressions from the same colour, I do not think it possible that any one accustomed to the use of colours would mistake yellow ochre for white.

In the case of *Jupiter*, means of comparison were never wanting: the light-belts N. and S. of the equatorial belt having, during the time of the change in the colour of this belt, always appeared nearly white.

I agree with Mr. Penrose that the colour of the equatorial belt appears paler than it did last year, but as the apparent diameter of the planet is smaller, as it is getting low in the heavens, and it now sets in twilight, I do not think much value should be attached to recent observations.

Mr. Ranyard informs me that he has found some observations of Schwabe on the colours of *Jupiter* in addition to the observations he had previously noted in his very interesting and useful paper on this subject published in the *Monthly Notices*.

On a New Spectroscopic Combination. By the Rev. Father Secchi.

(*Translation.*)

I have the honour to announce the discovery of a new spectroscopic combination by the aid of which it is possible to see the images of the solar spots and protuberances with the spectral rays; the whole in the same visual field. This result is arrived at in two different ways: 1°, by placing before the object-glass of the telescope a rather large prism, such as that which I use for the spectra of the stars, of six inches aperture; and by letting fall

on the slit of the ordinary spectroscope the coloured image produced at the focus of the telescope. 2°, the other less costly means consists in placing a direct-vision prism of great dispersive power in the course of the luminous rays before they arrive at the focus, and on the slit of the ordinary spectroscope.

By these two means we obtain in the field of the spectroscope the solar image formed of different coloured hues, with their spectral rays, but very precise and detailed, with the spots and edges very precise, so that it is possible to make out the details of the spots, as one would do with a coloured glass. If the solar edge falls near the ray C, which (as I have said) one sees at the same time with the image of the spots, one sees the chromosphere and protuberances mark themselves out like brilliant lines, more or less distant from the edge according to the height of the protuberances. The image of the spots is sharper as the slit is narrower. Thus one sees the protuberances as brilliant lines, but one only recognises their form by linear sections, as in Janssen's old method. It is, nevertheless, possible perfectly to make out and measure their height by measuring the distance of the (now brilliant) line C from the point of the solar boundary which is on the same normal therewith. One can also, by broadening the slit, make out the form of the protuberance, but there is then a loss of precision in the image. But keeping the slit narrow, one can make out with the greatest precision the height and place of the protuberances, and fix their position in respect to the spots and faculæ, in a much more simple and surer manner than with the ordinary spectroscope.

If in a spot there is a jet of hydrogen, one sees there the line C become brilliant, or at least diminish in blackness, and the calcium and iron lines grow broader, &c., as in the ordinary observations, but with greater satisfaction and accuracy of position.

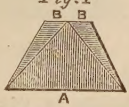
Note on the use of Compound Prisms. By John Browning, Esq.

As some attention is being directed to the use of compound prisms, I think it desirable to place on record in the *Monthly Notices* the steps I have taken towards their introduction.

In 1864 Mr. Gassiot asked me to make for him a very powerful battery of bisulphide of carbon prisms.

Instead of making the sides of these prisms of plane and parallel glass, I cemented crown-glass prisms on to them in the manner shown in the diagram (fig. 1), where A represents the fluid prism, and B B the crown-glass prisms added on either side.

Fig. 1



This battery of prisms was described in the *Proceedings of*

the Royal Society, vol. xiii. p. 185, in a paper read by Mr. Gassiot, April 7th, 1864. From this paper I take the following extract:—

"In place of giving to the fluid prisms two pairs of parallel sides, advantage has been taken by Mr. Browning of the difference between the refractive and dispersive properties of crown glass and bisulphide of carbon; and prisms of crown glass, having a refracting angle of 6°, have been substituted for one of the outer plates of each prism, the bases of these crown-glass prisms being brought to correspond with the apex of the fluid prism.

"By this means the angle of minimum deviation of the prisms is so much altered that eleven prisms can be used instead of eight. An increase of dispersive power, due to refracting angles of 150° of the bisulphide of carbon, is thus gained, minus only the small amount of dispersion counteracted by the dispersive power of the crown-glass prisms in the contrary direction."

In July 1869, at the suggestion of Dr. Robinson, of Armagh, I made a large dense glass prism of 60° into a compound prism, the refracting angle of the dense prism being altered to 90°.

Since that time I have made several compound prisms of very dense flint glass and light crown glass, for the present Earl of Rosse.

The reason I have not used such compound prisms more generally is that such prisms are more expensive than ordinary prisms, even allowing for the extra dispersive power obtained, and that in consequence of the minimum angle of deviation of compound prisms being greater, and their length greater, the size of spectroscopes would require to be increased, and they would thus be rendered more cumbersome, as well as more expensive.

A smaller number of compound prisms will produce a given amount of dispersion; but the number of prisms to be made is, under the most favourable circumstances, three instead of two; and in the case of a circular battery the smaller number of prisms will occupy a larger circle. The number of plane faces is also greater for a given amount of dispersion, the practical difficulties in securing accuracy not being diminished by the fact that four faces out of the six in a compound prism are connected together.

On the score of saving light such prisms possess undoubtedly some advantage.

After writing the above, Mr. Lewis Rutherford, of New York, has requested me to make him a compound prism of glass on a plan which seems to possess some advantages over any hitherto used. The diagram (fig. 2) represents this prism.

Fig. 2

In this diagram the two darkly shaded prisms are of dense flint of 90°, while the three other prisms are of crown. Such a prism is very nearly equal in dispersive power to three ordinary flint-glass prisms of 60°. There is no loss of light at the two intermediate surfaces, and it is much more compact.

I have found by experiment that the angles of the flint-glass prisms in this arangement cannot with advantage be made more than 90°, nor the outside crown-glass prisms less than 30°.

A Contrivance for a double Automatic Spectroscope, with compound Prisms on Mr. Grubb's plan. By Richard A. Proctor, B.A., Cambridge.

Mr. Browning having succeeded in constructing a double-battery spectroscope on the plan I submitted to the Society last December—with, however, a slight modification in the contrivance for automatic adjustment—I am encouraged to believe that the plan I am now about to describe will be found feasible; though certainly the difficulties which the optician will have to surmount are by no means slight.

I propose the substitution of Mr. Grubb's compound prism for the single prisms in my double battery, the single intermediate prism being replaced by an intermediate compound prism, shaped as shown in the accompanying view (fig. 1) of the complete

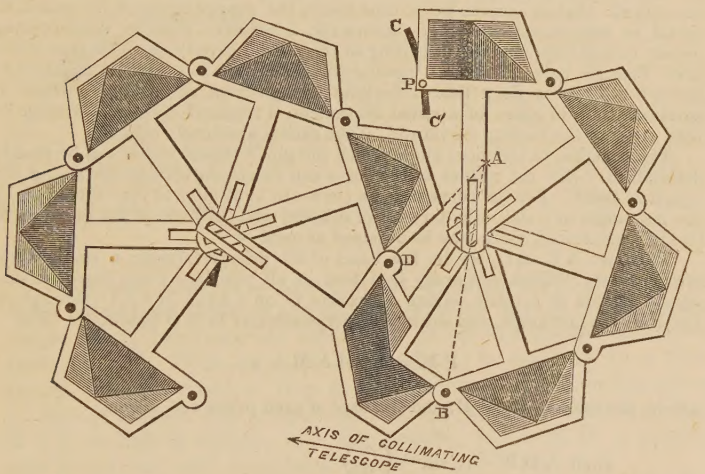


Fig. 1.

double battery. (The pivots on which the slots work have been omitted by the engraver.) This view, with the description given in my former paper serves to explain how the automatic adjustment is secured. But it will be noticed that the radial bar and the long slotted bar of the former description are removed. As I partly suspected when I suggested their use, they fail to communicate motion effectively to the second battery. The reason is easily seen: they work on that end of the second battery which

moves the most slowly, that is, where the leverage is least. When Mr. Browning found, on trial, that this was the case, another method—which, like the former, is theoretically exact—suggested itself to me. It is a property of the double battery that each prism of one battery has its base at right angles to some one prism of the other battery. Hence, if by means of a slotted T-square bar, this relation could be impressed on two corresponding prisms of the separate batteries, the adjustment would be mathematically exact. On trial, this method was found also to fail; and no other mathematically exact extension suggesting itself to me (and time pressing), I agreed that in the specimen double battery the last prism of the second battery should be carried by a simple radial motion making it travel as nearly as possible on its proper curve.*

* I should have preferred a cam, but Mr. Browning stated that there were practical objections. The theoretical advantage of a cam is, that the pivot p can be made to travel in the true curve, as C C′ (fig. 1). And in order to determine this curve, a construction founded on the plan first suggested by me could be adopted. Thus the dotted lines D A, B A show the position which the removed bars would take up. Now the motion of the first battery would bring these lines into position; and if then the slotted bars of the second battery were carried by means of their common pivot until this pivot was just centrally over the line A B, then the pin P would be in its proper place, which could readily be marked. Several marks being thus made, the proper figure of the cam C C′ would be determined, and more accurately, I conceive, than by endeavouring merely to make the amount of closing of the second battery equal to that of the first. That the curve C C′ is not circular will be obvious to every mathematician; nor is it difficult to show that it deviates enough from circularity to render it advisable that, in place of a radial movement, a trammel-movement should be used (to give the varying curvature), if the cam is absolutely rejected.

The equation to the *locus* along which the pin P should travel can be readily determined. But the *nature* of the curve can be shown without obtaining the equation itself. For the curve may be shown to be similar to that traversed by the last angle of a single battery of six prisms; and the form of the equation to this last-mentioned curve may be obtained at once—

Thus, let A B, B C, &c. be the bases of six prisms forming a single automatic battery. Then it is easily seen that in all positions these bases are successive chords of a circle having its centre O on a fixed line A O through A. Let P be the last angle, and draw P M perpendicular to A O produced. Put

$$\mathrm{P\,M} = x \text{ and } \mathrm{A\,M} = y;$$

and let the radius A O be R, and the base of each prism $2a$. Then,

$$\text{angle A O P} = 12 \sin^{-1}\left(\frac{a}{\mathrm{R}}\right)$$

$$y = \mathrm{R}\ (1 + \cos \mathrm{P\,O\,M})$$

$$= \mathrm{R}\left\{1 - \cos 12\left[\sin^{-1}\left(\frac{a}{\mathrm{R}}\right)\right]\right\} \qquad \text{(i)}$$

$$\text{and } x = \mathrm{R} \sin 12\left[\sin^{-1}\left(\frac{a}{\mathrm{R}}\right)\right] \qquad \text{(ii)}$$

Eliminating R between (i) and (ii), we shall obtain the equation to the *locus* of P, and the curve will clearly be of a very high order. It is, in fact, a some-

The proper shape for the intermediate prism is easily deduced. For let A D C B (fig. 3) be the half of one of Mr. Grubb's compound prisms. Then the light which is passing parallel to A B must be totally reflected by a face B E inclined at an angle of 45° to its course. We must therefore take B C E a half square. Then, that the exit of the light may be on a course exactly similar to its entrance, we must add the half of a compound prism C E G F exactly similar to B C D A. Thus the construction for determining the section A C F E B of the flint portion of the intermediate prism is obtained very readily by sole reference to the figure of half a compound prism.

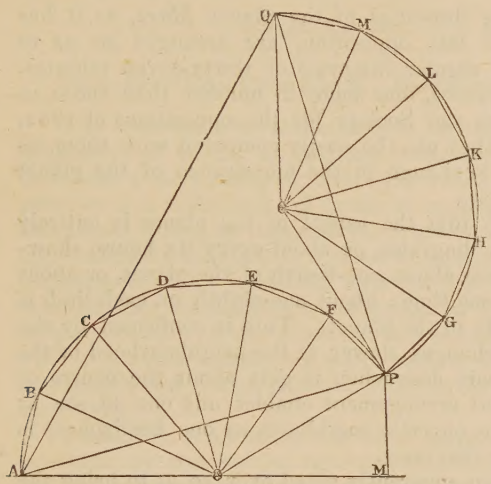
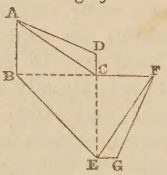


Fig. 2.

Fig. 3.



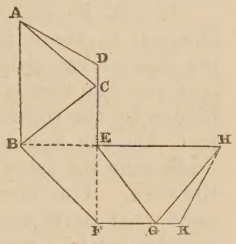


Fig. 4.

Note also that, if a symmetrical compound prism consist of more parts than three, a similar construction will give the proper shape for an intermediate compound prism in a double battery of such prisms. Thus, let A D C E B (fig. 4) be one half of a compound prism formed of five prisms; then the construction given in fig. 4 shows the proper section for an intermediate prism. B E F is half a square, and the portion E F G K H is exactly similar to the half-compound prism A D C E B.

The battery pictured in fig. 1 would give about twice the dispersion given by my double battery of single prisms: in other

what peculiar spiral. Now, if we add a second battery of the same number of prisms (an intermediate prism giving one total reflexion), we obtain the base lines P G, G H, &c., the centre O′ of the circle on which they lie being a tangent to the circle A D P. And it is easily seen that the last angle Q will always be so placed that A P Q is half a square. Hence the locus of Q is precisely similar to the *locus* of P, but enlarged in the proportion of $\sqrt{2}$ to 1, and tilted round A in the positive direction of angle-measurement, through 45 degrees.

words, it would give a dispersion equal to that given by 36 equilateral prisms of heavy flint glass. It will be understood that the light is taken twice through the double battery, returning at a higher level, after exactly the same fashion as in the battery described by Mr. Grubb in the December number of the *Monthly Notices.*

Observations of Mars, with Drawings.
By John Joynson, Esq.

The accompanying drawings of the planet *Mars*, as it has been seen during the late opposition, are arranged so as to exhibit its aspect at regular intervals of thirty-seven minutes. There are, in consequence, four more in number than those in the sets already sent to the Society for the oppositions of 1862, 1864, and 1867; but they can be easily compared with them, as there has been but little change in the appearance of the planet since the last opposition.

It will be noticed that the aspect of the planet is entirely changed in about ten diagrams, or about every six hours, showing that we can only see about one-fourth of the planet, or about half the true disk at one time ; about one-eighth on each limb is hidden by the rotundity of the planet. This is confirmed by the fact that the aspect changes slower at the neighbourhood of the limbs than the same part does when it gets about the centre of the disk. The present arrangement enables any one to see at once what parts are on opposite meridians, as one hemisphere is represented by twenty diagrams.

The planet has been apparently tilted over, so as to bring the North Pole more directly towards us, though the effect is more perceptible on the southern limb than about the pole itself. The North Polar snow has been of much smaller extent than it was at the last opposition, and has had very much the appearance of that at the South Pole, as seen in 1862. It has not been quite on the limb, as it has appeared somewhat larger on one side than on the opposite : though it has sometimes, even on both, appeared perfectly round, owing to its smallness and brightness. There is only one other remark to make as to any apparent change on the disk, and that is, that the watery projection from the North Polar snows seen about the 22nd March has been much larger than at the last opposition; indeed the whole disk about the pole has been darker than previously.

The general colour of the disk (saving the band and the channel from it to the circumpolar waters) has been yellowish, with a brownish tinge towards the pole. But it is difficult to say what the real colour is, for the same part of the disk has varied from night to night from dark-yellow to very nearly white, according to the state of our own atmosphere.

These drawings, in conjunction with those previously sent, prove beyond doubt that the "band" and "wine-glass shaped channel" from it, are permanent features of the planet, and that any apparent change in them arises from the various aspects that are presented by the planet itself, as seen from the Earth.

In addition to the above set of drawings, I send copies of those already sent for the oppositions in 1862, 1864, and 1867, arranged so that the corresponding drawing for each appears under that for the previous opposition, thus showing the apparent changes, and facilitating their comparison.

Waterloo, near Liverpool, 10 *May*, 1871.

On a Free-Regulator Clock. By Sidney B. Kincaid, Esq.

The common pendulum-clock is essentially a very imperfect adaptation of theory to practice, because, while the theory contemplates a body swinging under the action of a *constant* force, in practice it is influenced by forces so various that it is only with the utmost difficulty that a clever workman can render their sum approximately constant in a clock of moderate size, and when the requirement that it should drive a pair of large hands on a weather-dial necessitates construction on a scale belonging rather to the province of the engineer, it is deemed indeed a triumph of skill to produce a timepiece which can be depended on as such for any lengthened period without frequent correction by the transit-instrument.

I would now submit to the Royal Astronomical Society a plan in which, by making the regulator mechanically free of the going and recording apparatus, the difficulty of construction I have referred to is obviated, inasmuch as a slight want of care and accuracy in the finish of these latter parts of the clock does not tend to impair the exactness of its performance.

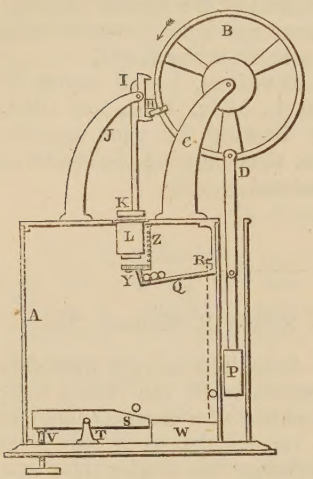
I propose, as will be seen, to substitute for the pendulum as the controlling agency, iron spheres falling *in vacuo*, and to record the falls and replace the spheres by means of a galvanic current. No doubt some unaccustomed to its use may feel prejudiced against the employment of electricity, but with a self-amalgamating Smee, or a constant, battery, there need be no much trouble about it.

In the diagram:—

A, is the case, exhausted of air to prevent unequal resistances due to changes of temperature.

B, a wheel (C its support) on the axis of which and connected to it is a pinion, such that if $\frac{1}{t}$ be the fraction of a second occupied by the falling of a ball, 60 t turns of B make one turn of seconds-wheel of clock. To the edge of B is fixed by a loose pin,

D, a rod carrying the permanent magnet P, which slides up and down against outside of case.



H, is the pin of C, which engages the escapement I (J its support) to which is attached the armature K acted on by the electro-magnet,

L, within the case. *Inside* the case are also,—

Y, the release-piece with its spring Z:

O, a lever turning on centre T and resting in its normal position on the screw V, by which the circuit is closed between battery and magnet:

W, the lower inclined plane.

R, a stop just above Q, and,

Q, the upper incline.

Y is supported by two standards, not shown in diagram, constructed on principle of gridiron pendulum, so that its height may be the same at all temperatures. For the sake of clearness the electrical connexions are also omitted.

The action of the apparatus is as follows:—

A ball having fallen, immediately that it meets S, it breaks contact, the piece Y tilting sideways then instantly disengages another ball, and the escapement armature K no longer being held by the magnet, allows the wheel B to be turned once by the clock train, this raises the magnet P, drawing up the ball on W until it meets the stop R, which releases it from the magnet, and leaves it to roll against a stop-pin and against Y, and lets (P) down again; meanwhile the ball which fell has rolled down S and W into position to be picked up in its turn, and S being relieved of its weight, contact is restored; when the next ball strikes S the same movements take place. A guard-pin prevents more than one ball being liberated at once by Y. Of course L must be so placed as not to act directly on the balls.

Trinity College, Cambridge, May 6, 1871.

On η Argûs. By J. Tebbutt, Esq.

The accompanying table exhibits the results of comparisons of η *Argûs* made by me during the period 1854–1870. The magnitudes of the comparison stars employed down to the end of 1863, have been taken from Tables A and C on pp. 334, 341, of Sir J. Herschel's *Results of Astronomical Observations at the Cape of Good Hope*, 1834–8. For all the observations since

that year magnitudes have been assigned to the comparison stars in accordance with my own estimates. I have divided the series of observations into groups, each group having concluded magnitudes nearly agreeing with one another. The mean date and magnitude for each group have then been determined. On projecting these results in a curve, it will be seen that during the past three years there have been small annual fluctuations in the light of the star. Whether the curve represents with any approach to accuracy the real fluctuations in the light of the Variable must, of course, depend on the value to be attached to my judgment in the comparison observations. Of this, however, I am quite certain, that *η Argûs* has been alternately above and below a mean magnitude during the past three or four years, and that the limit of these fluctuations from maximum to minimum is about a quarter of a magnitude. For the past three years the star has been invisible to the naked eye.

In conclusion, I may state that of the stars contained in the Catalogue on p. 42 of the work before referred to those numbered 387 and 522 are very nearly equal, the latter being somewhat the brighter. These stars are marked in the Catalogue as of the 6th and 7th magnitude respectively. 1203 is considerably brighter than 1183, although the catalogue gives 7 and 6 as their respective magnitudes.

	Dates of the Comparisons.	Mean Date of Comparison Year	Day	Mean of concluded Mags.
1854	July 5	1854	186	1·10
1860	May 4, 18..	1860	132	3·41
1862	Jan. 23, 26; June 23; July 3, 4, 7, 10, 11, 15, 16, 17, 18, 22, 24, 25, 26; Aug. 22, 27, 28..	1862	184	4·57
1863	April 15, 16; May 24	1863	118	4·66
1864	March 23; April 23; May 6, 11, 31; July 28	1864	136	5·13
1865	Feb. 22, 23, 24; March 14	1865	59	5·25
1866	Feb. 16; March 22; June 29; July 2, 4 ..	1866	135	5·52
1866	Dec. 3, 8, 11, 12. 1867, Jan. 12, 26; March 2; April 17; May 4; July 27	1867	45	6·04
1867	Dec. 28, 31	1867	364	6·35
1868	Feb. 26, 27	1868	58	6·20
1868	April 13, 22, 29; May 9, 16, 19, 22, 26; June 12; July 21, 31; August 24; Dec. 17	1868	169	6·30
1869	Feb. 8, 18, 23	1869	47	6·20
1869	March 10; April 19; May 19	1869	106	6·32
1869	May 26; June 25; July 23; August 10; Sept. 6, 21; Dec. 6, 25. 1870, Jan. 8, 13.. ..	1869	271	6·39
1870	Jan. 22, 28; Feb. 8, 25; March 25, 26 ..	1870	52	6·25
1870	May 7; June 3, 6, 7, 16; July 4; August 20, 25; Sept. 26, 27	1870	196	6·40
1870	Nov. 28; Dec. 6, 29	1870	345	6·25

Windsor, N. S. Wales, February 23, 1871.

On the Total Solar Eclipse of 1878, *July* 29.

By J. R. Hind, F.R.S.

The following particulars relating to this eclipse may be of interest in anticipation of the appearance of the various ephemerides for the year. They are founded upon the tables of Damoiseau and Carlini, but will afford a pretty close approximation to the actual circumstances of the eclipse. No doubt every possible use will be made of this phenomenon by the astronomers of the United States.

Elements.

G.M.T. of Conjunction in R.A. 1878, July 29, $9^h\ 22^m\ 11^s.7$

R.A. of Sun and Moon	..	128° 56′ 4″.5
Hor. Mot. in R.A.	Sun	2 26.7
,,	Moon	35 59.3
North Declination	Sun	18 39 3.2
,,	Moon	19 18 33 3
Hor. Mot. in Decl.	Sun	— 0 35.9
,,	Moon	— 12 9.8
Hor. Parallax	Sun	8.8
,,	Moon	59 36.7
Semi-diameter	Sun	15 47.7
,,	Moon	16 16.3

The following points will indicate the course of the central eclipse:—

Central beginning	117° 48′ E	54° 17 N
	178 55 E	65 57
	142 52 W	61 58
Sun on Meridian	139 0	60 32
	135 50	59 31
	132 29	58 9
	123 31	53 19
	116 43	49 16
	110 26	44 20
	97 7	33 4
	90 49	28 23
	82 29	23 19
Central ending	69 31 W	16 56 N

Special calculations for various points near the line of central eclipse:—

(1). For 135° 50′ W., 59° 31′ N., the Sun nearly on the Meridian.

	h m s	
Totality begins	0 21 29·7	Local Mean Time.
,, ends	0 24 35·8	
∴ Duration	3 6·1	
Sun's Altitude	50°	

(2). For Denver, Colorado.

	h m s	
Totality begins	3 29 0·3	Denver M.T.
,, ends	3 31 46·8	
∴ Duration	2 46·5	
Sun's Altitude	42°	

(3). For Havannah, Cuba.

	h m s	
Totality begins	5 34 31·8	Havannah M.T.
,, ends	5 36 25·2	
∴ Duration	1 53·4	
Sun's Altitude	16°	

(4). For Port-au-Prince, Hayti.

	h m s	
Totality begins	6 18 46·1	Port-au-Prince M.T.
,, ends	6 20 10·1	
∴ Duration	1 24·0	
Sun's Altitude	4°	

The greatest duration of totality on the central line will be about $3^m\ 8^s$, and the mean semidiameter of the zone of totality in the United States about 51′.

I have carefully examined every part of the above calculation, a very necessary precaution when eclipse-work is undertaken by a single computer.

The Occultation of Uranus on Thursday, March 2, 1871.

By J. Maguire, Esq.

In the last Number of the *Monthly Notices* Captain Wm. Noble states a circumstance which leads him to doubt the accuracy of the time of disappearance of *Uranus*, as shown in page 452 of the *Nautical Almanac*. He says that returning at $14^h\ 5^m$ sidereal time to his Equatoreal which had been previously set upon *Uranus*, he found that the planet *had disappeared* two minutes before the predicted time. The times are as follows :—

	S.T. h m	M.T. h m
Disappearance	14 7	15 25
Reappearance.....	15 0	16 19

I have made a calculation of the time of disappearance which I find to be $15^h\,24^m\,43^s$, and this agrees well with the $15^h\,25^m$ of the *Nautical Almanac*, which rejects in the list of Occultations all subdivisions of the minute; but I find there is a difference in the time of reappearance—my calculation being $16^h\,18^m\,9^s$ against the *Nautical Almanac* $16^h\,19^m$, which it may be noticed is not the equivalent for $15^h\,0^m$ sidereal time.

If Captain Noble's observation was made at Maresfield, the mean time of disappearance there would be about $15^h\,25^m\,44^s$.

But how is the observation to be reconciled with the calculated time? Must we conclude that the tabulated places of the Moon or *Uranus* in the *Nautical Almanac* are wrong*—or with respect to the observation itself, may we not entertain a doubt as to the presence of some of the conditions which are essential to a good determination.

Norwich, 26 *April*, 1871.

On the First Comet of 1867. By J. R. Hind, F.R.S.

In No. 1639 of the *Astronomische Nachrichten*, Professor Winlock has given elliptic elements of the comet discovered at Marseilles by M. Stephan, in January 1867, calculated by Mr. Searle, of Harvard Observatory, Cambridge, U. S., in which the period of revolution is 33·62 years. These elements are stated to represent closely the observations taken with the great refractor of that observatory; and those who have had occasion to use the Harvard observations will be aware that they possess an extreme precision.

I have remarked in this orbit a very near approach to that of the planet *Uranus*, when the comet passes its descending node (5789 days before perihelion). At this point the comet's heliocentric ecliptical co-ordinates are

$$x = -3{\cdot}784730 \qquad y = -18{\cdot}763121 \qquad z = 0$$

and in this longitude the similar co-ordinates of *Uranus* are

$$x = -3{\cdot}784974 \qquad y = -18{\cdot}764332 \qquad z = -0{\cdot}023115$$

whence the distance between the two orbits is 0·02343 only; an approximation which appears to explain the cause of the actual form of the comet's orbit.

* It was noticed at the Meeting, that the existing Tables of *Uranus* (Bouvard's), from which the *Nautical Almanac* places are calculated, are confessedly inaccurate to an extent which quite accounts for the error.—Ed.

It is also to be remarked that there is a singular commensurability in the periods

$$5 \times \text{sidereal period of Comet} = 168^{\text{yrs.}}\cdot120$$
$$2 \times \text{sidereal period of } \textit{Uranus} = 168\cdot032$$

affording a parallel to the well-known 5 to 2 relation in the great inequality of *Jupiter* and *Saturn*.

If Mr. Searle's elements are nearly correct (as appears to be the case), the comet would not suffer any extraordinary perturbation about the nodal passage in 1817, the nearest approach to *Uranus* being then about 1·05; but in 1649 the distance between the two bodies may have been much less.

Ephemeris of the Periodical Comet of Tuttle, for its approaching Reappearance. By J. R. Hind, F.R.S.

In No. 1840 of the *Astronomische Nachrichten*, Prof. Luther has published an orbit of this comet found amongst the papers of the late Dr. Tischler, of Königsberg, in which the perturbations during the present revolution had been partially included. According to these elements the next perihelion passage will occur about 1871, Nov. 30·5, and on this assumption I have calculated the following ephemeris to facilitate the comet's rediscovery. The expressions for the comet's heliocentric co-ordinates referred to the Mean Equinox of 1871·0 are

$$x = r\,.\,[9\cdot7663098]\,.\,\sin(v + 205^{\circ}\,35'\,31''),$$
$$y = r\,.\,[9\cdot9888950]\,.\,\sin(v + 97\;\;1\;\;10),$$
$$z = r\,.\,[9\cdot9253116)\,.\,\sin(v + 178\;34\;48).$$

Ephemeris for Greenwich Noon.

T = 1871, Nov. 30·5.

1871.	R.A.	Decl.	Log Δ.	Log r.	$\frac{1}{r^2\,\Delta^2}$
Sept. 1	100° 13′·2	+62° 22′·7	0·2377	0·2201	0·12
3	102 30·5	61 56·4			
5	104 45·0	61 27·4	0·2221	0·2094	0·14
7	106 56·6	60 55·6			
9	109 5·3	60 21·1	0·2059	0·1984	0·16
11	111 10·9	59 43·8			
13	113 13·4	59 3·7	0·1890	0·1873	0·18
15	115 12·8	58 20·7			
17	117 9·1	57 34·9	0·1713	0·1760	0·20
19	119 2·1	56 46·2			
21	120 52·0	55 54·5	0·1628	0·1645	0·23
23	122 38·8	54 59·8			

1871.	R.A.	Decl.	Log Δ.	Log *r*.	$\frac{1}{r^2\Delta^2}$
	° ′	° ′			
Sept. 25	124 22·5	54 2·1	0·1335	0·1530	0·27
27	126 3·1	53 1·3			
29	127 40·8	51 57·2	0·1134	0·1413	0·31
Oct. 1	129 15·7	50 49·5			
3	130 47·8	49 37·9	0·0924	0·1297	0·36
5	132 17·3	48 22·4			
7	133 44·3	47 2·6	0·0706	0·1180	0·42
9	135 8·9	45 38·4			
11	136 31·3	44 9·4	0·0479	0·1065	0·49
13	137 51·5	42 35·5			
15	139 9·7	40 56·3	0·0245	0·0951	0·58
17	140 25·9	39 11·4			
19	141 40·0	+37 20·8	0·0003	0·0839	0·68

The comet's track in the heavens would, therefore, appear to be very favourable for observation in these latitudes.

Note on the Re-appearance of Encke's Comet in 1871.
By J. R. Hind, F.R.S.

The approaching re-appearance of the Comet of Encke is likely to take place under nearly the most favourable circumstances possible for observation in the Northern hemisphere. Complete ephemerides will no doubt be issued from Berlin in due time. Meanwhile the following places may serve to indicate its earlier position in the heavens. They are computed on the assumption that the perihelion passage takes place in 1871, Dec. 29·0, which is about the time assigned by Prof. Förster's elements for the last return in 1868, neglecting perturbations.

0h G.M.T.	R.A.	Decl.	Log. Δ.
	° ′	° ′	
Aug. 21	31 11	+24 4	0·1929
31	31 48	26 0	0·1284
Sept. 10	31 32	28 8	0·0561
20	29 57	30 32	9·9750
30	26 18	33 13	9·8842
Oct. 10	19 19	+36 4	9·7841

On De Vico's Comet of Short Period. By J. R. Hind, F.R.S.

It is well known that the periodical comet detected by De Vico at Rome in 1844, August 22, has not been observed at any one of its returns since that year. In 1850 its position in the

heavens was very unfavourable, and in 1855, when observations were expected, possibly from the prevalence of clouded skies, it escaped notice again. Nor at its returns in 1860 and 1866 was it detected, though in the former year it was sought for with the great refractor of the Harvard Observatory, and in the latter year I circulated a sweeping Ephemeris. Another return to perihelion must be approaching, but from the elaborate investigations of Prof. Brünnow, there appears to be so much uncertainty attaching to the value of the mean diurnal motion in 1844, notwithstanding the fine series of observations made by Mr. Otto Struve at Poulkova, that the date of next perihelion passage can hardly be assigned with any degree of confidence within several months. We must, therefore, in all probability depend upon the success of those who occupy themselves in sweeping the heavens for telescopic comets, to recover it once more. (See Professor Brünnow's remarks in the Ann Arbor *Astronomical Notices*, No. 3.)

The following values of the comet's heliocentric equatorial co-ordinates from 130 days before, to 90 days after perihelion, may perhaps assist in identifying it, should an accidental discovery be made:—

Days from Perihelion.	x	y	z	Log. r.
−130	−0·5221	−1·6640	−0·7401	0·27746
120	0·3791	1·6221	0·7280	0·25953
110	0·2343	1·5723	0·7123	0·24099
100	−0·0881	1·5136	0·6927	0·22185
90	+0·0586	1·4452	0·6686	0·20228
80	0·2048	1·3663	0·6396	0·18248
70	0·3493	1·2759	0·6053	0·16272
60	0·4904	1·1732	0·5651	0·14344
50	0·6261	1·0577	0·5187	0·12513
40	0·7540	0·9290	0·4659	0·10850
30	0·8713	0·7874	0·4066	0·09434
20	0·9752	0·6338	0·3411	0·08348
−10	1·0628	0·4696	0·2699	0·07654
0	1·1323	0·2974	0·1941	0·07428
+10	1·1812	−0·1198	0·1148	
20	1·2101	+0·0598	−0·0335	
30	1·2187	0·2384	+0·0483	
40	1·2086	0·4135	0·1295	
50	1·1817	0·5828	0·2088	
60	1·1401	0·7450	0·2856	
70	1·0859	0·8989	0·3592	
80	1·0212	1·0442	0·4294	
+90	+0·9480	+1·1807	+0·4960	

In computing the above co-ordinates the values of π, Ω, and

i in Prof. Brünnow's orbit for 1855 (*Mémoire sur la Comète Elliptique de De Vico*) were brought up to 1872.0 and adopted.

I may here remark that the time of the next return of Peters' periodical Comet is much more uncertain than that of De Vico's, and the only chance of recovering it will be in the manner I have alluded to above. The last calculations of Dr. Peters with reference to this comet are those detailed in Prof. Brünnow's *Astronomical Notices*, as I learned in conversation with Dr. Peters last December.

Elements and Ephemeris of the First Comet of 1871, *discovered by Dr. Winnecke on April* 7. By J. R. Hind, F.R.S.

From Dr. Winnecke's observation on April 7th and two at Mr. Bishop's Observatory on the 12th and 19th I have calculated the following parabolic elements, taking all the small corrections into account:—

Perihelion Passage, 1871, June 10·9958, G.M.T.

Longitude of Perihelion	139° 43′ 19″	Mean Equinox 1871·0.
Longitude of Ascending Node ..	278 40 45	
Inclination	87 54 10	
Log. Perihelion distance.....	9·8292565.	

Motion direct.

$$x = r \,.\, [9{\cdot}19083] \,.\, \sin (v + 297^\circ\ 33'{\cdot}7),$$
$$y = r \,.\, [9{\cdot}99486] \,.\, \sin (v + 107\ 37{\cdot}7),$$
$$z = r \,.\, [9{\cdot}99985] \,.\, \sin (v + 197\ 51{\cdot}7).$$

The following Ephemeris shows that there is a probability that the comet may be observed after the perihelion passage, if sought for at the Southern observatories:—

At Greenwich Noon.

1871.	R.A.	Decl.	Log. Δ.	Log. r.	$\frac{1}{r^2 \,.\, \Delta^2}$
	° ′	° ′			
June 24	94 11	− 5 50	0·1509	9·8616	0·94
28	96 44	10 1	0·1356	9·8816	
July 2	99 33	14 21	0·1197	9·9041	0·90
6	102 42	18 50	0·1043	9·9281	
10	106 17	23 28	0·0900	9·9527	0·82
14	110 23	28 14	0·0775	9·9774	
18	115 7	33 5	0·0673	0·0017	0·73
22	120 36	37 54	0·0606	0·0255	
26	126 59	42 32	0·0580	0·0484	0·61
30	134 23	−46 50	0·0595	0·0705	

Protocolle der Verhandlungen der zweiten Conferenz der Commission für die Vorberathung der Beobachtung des Venusdurchgangs von 1874. Berlin, 27–28 Marz, 1871.

The commissioners present were Hansen, Argelander, Paschen, Seidel, Schönfeld, Bruhns, Förster, Rümker, Auwers, and Winnecke. It was resolved that there should be four heliometer-stations, viz. in the northern hemisphere, one in Japan or China (it being assumed that there would be a Russian heliometer-expedition or expeditions to north-eastern Asia), and in the southern hemisphere three, viz. two in the neighbourhoods of Kerguelen's Island and Auckland's Islands, and the third at Mauritius. And four photographic stations, viz. the northern heliometer-station, those of Kerguelen's and the Auckland Islands, and a station in Persia between Mascat and Teheran. It was considered that there would be required nine astronomers, eight photographers, and nine assistants.

Ueber das Rotations-gesetz der Sonne und der grossen Planeten, von F. Zöllner (from the Berichten of the R. Saxon Society of Sciences, Feb. 1871, *pp.* 49–113.)

The daily rotation-angle of a point on the Sun's surface, as determined by observations of the spots, is found to vary according to the latitude ϕ of the point on the Sun's surface, and Mr. Carrington obtained for this angle the empirical value

$$\xi = 865' - 165' \sin^2 \varphi,$$

but for this M. Faye proposed to substitute,

$$\xi = 862' - 186' \sin^2 \varphi,$$

The author, making certain suppositions as to the fluid or gaseous envelope of the Sun, arrives at an expression of the form,

$$\xi = \frac{A - B \sin^2 \varphi}{\cos \varphi}$$

and he finds from the observations

For North Hemisphere	For South Hemisphere
$A = 863'{\cdot}8$	$A = 861'{\cdot}8$
$B = 613{\cdot}2$	$B = 620{\cdot}2$

or assuming for A in the two hemispheres the common value $= 863'{\cdot}8$, then the values for B in the two hemispheres are $= 613'{\cdot}2$ and $631'{\cdot}1$ respectively. He finds that his formulæ represent the observations somewhat better than either of the

former ones (but the difference is by no means striking). He examines also in connexion with observations by Spörer the formula

$$\xi = \frac{A' - B' \sin^2 \varphi}{\cos \varphi} - C' \sin \varphi$$

with the values

$$A' = 877''{\cdot}07$$
$$B' = 387{\cdot}07$$
$$C' = 154{\cdot}39$$

The memoir contains also a discussion of the evidence afforded by the observations of *Jupiter* and *Saturn* of a like drift of the exterior envelopes over the surfaces of the planets, and various discussions as to the phenomena generally.

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